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Zachary P. Roehrs
Laramie County Community College, zroehrs@lccc.wy.edu

Russell A. Benedict
Central College, Pella, IA, benedictr@central.edu

Thomas E. Labedz
University of Nebraska State Museum, tlabedz1@unl.edu

Hugh H. Genoways
University of Nebraska - Lincoln, h.h.genoways@gmail.com

Observations on the Distribution and Status of Selected Nebraska Mammals

Zachary P. Roehrs,[1] Russell A. Benedict,[2] Thomas E. Labedz,[3] and Hugh H. Genoways [3*]

1 School of Math and Sciences, Laramie County Community College, Cheyenne, WY 82007 USA
2 Department of Biology, Central College, Pella, IA 50219 USA
3 University of Nebraska State Museum, University of Nebraska-Lincoln, Lincoln, NE 68588 USA

*Corresponding author: Hugh H. Genoways, (402) 488-5467; h.h.genoways@gmail.com

Abstract

Information on the distribution and current status of 25 species or subspecies of mammals occurring in Nebraska are presented. The species covered include one shrew, an armadillo, eight bats, 10 rodents (including two subspecies of one species), three carnivores, and one artiodactyl. Distributional information reported includes the first state record for one species (*Sorex nanus*) and new county records for 18 species. In Nebraska, we know that mammals are shifting their geographic ranges with some extending populations into the state, whereas others are expanding their geographic ranges within the state. The current status of six additional mammalian taxa in Nebraska is documented, providing knowledge important to the conservation of these species during this time of shifting environmental conditions. The concern is that some mammals have suffered population declines since the 1940s and may have a contracting geographic range as well in the state. These species would be endangered and could be lost to the mammalian fauna of the state. Extensive data on reproduction in these mammals are presented and the taxonomy of species is updated from the 1964 Mammals of Nebraska by Jones.

Keywords: conservation concern, current status, distribution, mammals, reproduction, Nebraska, *Sorex nanus*, taxonomy

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Introduction

There is a long history of mammalian faunal investigations occurring in Nebraska. The first of these professional investigations was conducted by Merritt Cary (1905) while he was employed by the U. S. Biological Survey. Unfortunately, intervening events and his untimely death resulted in the report never being published, but a copy of the manuscript is on file with the U. S. Fish and Wildlife Service (Schmidly 2016). The first published listing of the mammals of Nebraska was by Myron H. Swenk in 1908; it was updated periodically over the next several years. The most complete survey of Nebraska's mammals, published in 1964 by J. Knox Jones, Jr., has remained the standard reference for the state for the last 56 years.

There was a steady appearance of research on Nebraska mammals through the remainder of the twentieth century, but since 2000 there has been an explosion of new research on mammals in the state, with many of these papers cited herein. One of the products of this recent work was a revised checklist, key, and bibliography of Nebraska mammals (Genoways et al. 2008). This research has emanated from several centers in the state that focus on mammals, including Keith Geluso and his students at the University of Nebraska-Kearney; Kenneth Geluso and Jeremy White and their students at the University of Nebraska-Omaha; Patricia Freeman, Scott Hygnstrom, Cliff Lemen, and Hugh Genoways and their students at the University of Nebraska-Lincoln (UNL).

The primary purpose of this paper is to report results from a survey of rare and at-risk Nebraska species conducted in summer 2004 when field parties from the University of Nebraska State Museum (UNSM) collected mammals in counties around the periphery of the state. A second objective of this report is to provide information on material that has been deposited in the UNSM since this survey from other sources, including Game and Parks personnel, students, general public, and other Nebraska institutions. Herein we report the first state record for one species, new county records for 18 species, and information on the status of six mammalian taxa in Nebraska, which add knowledge important to the conservation of these species in the state during this time of shifting environmental conditions.

Methods and Materials

Surveys targeting specific mammals of conservation concern were conducted from May to August 2004 using a variety of techniques in compliance with the "Guidelines

of the American Society of Mammalogists for the use of wild mammals in research and education" (Sikes et al. 2016). Small and medium-sized mammals were caught using Havahart (Woodstream Co., Lancaster, PA), LFA Sherman live traps (H.B. Sherman Traps Inc. Tallahassee, FL), and Museum Special snap traps (Woodstream Corporation, Lancaster, PA). These were used for a total of 32 nights (2523 trap nights) conducted throughout the state. Pitfall traps were used to capture small mammals not easily taken in other trap types (primarily *Sorex* spp.). These were set in groups of 2 to 4, connected by drift fences and operated for 25 nights (1187 trap nights) in northeastern and northwestern Nebraska. Pocket gophers were trapped for 8 nights (160 trap nights) in western Nebraska with Macabee Gopher Traps (Macabee Gopher Trap Company, Los Gatos, CA) modified for live trapping. Bats were caught using mist nets (Avinet Research Supplies, Portland, ME; 6 to 18 meters in length) set over streams, roads, and stock tanks. In some cases, especially in treeless areas of western Nebraska, shotguns were used to collect bats. We caught bats on 39 nights (179 net nights) in counties across the state. All specimens collected were deposited as voucher specimens with accompanying field notes in the UNSM.

Other records presented herein have come to the UNSM from various sources. Several records are from salvaged road-killed animal presented by the Nebraska Game and Parks Commission, other specimens came from programs at other institutions in the state, and still others came from students in classes at UNL.

Localities are basically as written by the collector of the specimen. Anything, including georeferencing information, that has been added to enhance locality information will appear in brackets [ ]. Latitude/longitude data are presented in a standard decimal degree format accomplished by inserting the collector's latitude/longitude data into the Google Earth website, verifying the resulting plot as matching the written site description, and transferring the decimal degree result for use herein. Locations without collector-generated latitude/longitude were entered into the domestic names search feature of the USGS Board on Geographic Names website <www.usgs.gov/core-science-systems/ngp/board-on-geographic-names/domestic-names>. The result was plotted using USGS topographic map features of the website. Once confirmed that the location matched the written description, a point was marked and the resulting decimal degree latitude/longitude transferred for use herein. Those latitude/longitude appearing without brackets were recorded by the collector and those with brackets we have added.

Weights were taken with Pesola spring scales (Pesola Präzisionswaagen, Schindellegi, Switzerland). All measurements are given in millimeters. All weights are grams unless otherwise noted.

Species Accounts

The following section is composed of accounts for 25 species or subspecies of mammals from Nebraska, describing new information about distributions, current status, and reproductive information. The species covered include one shrew, an armadillo, eight bats, 10 rodents (including two subspecies of one species), three carnivores, and one artiodactyl. Each location includes the number of specimens examined, with permanent catalog number(s) at the UNSM.

Sorex nanus

Dwarf shrew

Specimen examined (1).—Sioux Co.: Oglala National Grassland, 19.6 mi N, 0.3 mi E Harrison P.O., T35N, R56W, Sec.35, NE1/4, NE1/4 [42.9701, -103.8774], 1 (UNSM ZM-28984).

Remark.—Our specimen represents the first record of the dwarf shrew in Nebraska. This dwarf shrew captured on 31 July 2004 was a reproductively inactive male (testes length less than 0.5) taken in a pitfall trap placed on a hilltop in the Oglala National Grassland. Vegetation at this site is of the Pierre Shale Outcrop, Northwestern Mixedgrass Prairie community (Rolfsmeier and Steinauer 2010), including blue grama *(Bouteloua gracilis*), side-oats grama (*Bouteloua curtipendula*), an annual brome (*Bromus* sp.), prickly pear (*Opuntia* sp.), and many forbs. The vegetation was sparse and the soil was rocky, containing heavy layers of clay. This region is dry, receiving an average of 41 cm of precipitation per year, and was experiencing a moderate to severe drought at the time of capture.

The nearest record for a dwarf shrew is from the Hat Creek Bridge on State Highway 71, ≈15 mi S Hot Springs, Fall River County, South Dakota (Martin 1971). This record, based on a left mandible with teeth in place removed from an owl pellet, was found ≈25 mi north of our site. The relationship of dwarf shrews on the Great Plains will be discussed in a subsequent paper (Benedict et al. 2021).

Dasypus novemcinctus mexicanus

Nine-banded armadillo

Specimens examined (4).—Butler Co.: 8 mi S Columbus [*in* Platte Co.], County Road 40 just E of U.S. Hwy 81 [41.3227, -97.3666], 1 (UNSM ZM-30747). Clay Co.: no specific locality, 1 (UNSM ZM-30964). Lancaster Co.: 98th & Yankee Hill Road, Lincoln [40.7258, -96.5894], 1 (UNSM ZM-30965). Nemaha Co.: *in* Brock [40.4803, -95.9600], 1 (UNSM ZM-30963).

Sight records.—Kearney Co.: 5 mi N Minden (intersection Hwys 10 & 6) on Hwy 10 [40.5760, -98.9518] (Labedz, personal observation). Lancaster Co.: downtown Lincoln [40.8117, -96.7070] (Johnson 2018). Platte Co.: 7 mi SW Columbus (Schucht 2018). Saline Co.: Crete [40.6257, -96.9605] (Bergin 2015).

Remarks.—We report museum specimen records documenting the occurrence of armadillos in four counties and confirmed sight records from four counties. This brings the total to 16 counties in which nine-banded armadillo have now been recorded in Nebraska. Freeman and Genoways (1998) first reported specimen records of armadillos from four counties (Dundy, Otoe, Valley, and York) and newspaper and citizen-reported records from seven counties (Chase, Clay, Custer, Furnas, Jefferson, Lancaster, and Saline). Geluso et al. (2014) added a fifth specimen record in the state based on an individual taken in Lincoln County near the confluence of the North and South Platte rivers. Our specimens, therefore, represent the sixth to ninth specimens recorded from the state. The specimens from Clay and Lancaster counties verify previous sightings reported from these counties. The Minden record, which is the first record from Kearney County, was positively identified by Labedz based on a mangled roadkill on 3 June 2007 at a place where Highway 10 crosses Dry Creek.

The record from Benkelman, Dundy County (Freeman and Genoways 1998), is the western-most in the state and a line connecting it to sites west of North Platte, Lincoln County (Geluso et al. 2014), to the west of Ord in Valley County (Freeman and Genoways 1998), to a place in northwestern Butler County, and to Unadilla in Otoe County (Freeman and Genoways 1998) would circumscribe the geographic range of the armadillo in Nebraska from which there are documented occurrences. There are no records of armadillos from South Dakota, immediately north of this area in Nebraska, but there is a record from the southwestern portion of the state at Sharps Corner, Oglala Lakota County, just south of Badlands National Monument (Platt et al. 2009). Platt et al. (2009) believed the record was from too far north and west to be explained by natural movement so offered the explanation: "Local residents speculate that the armadillo was inadvertently transported to South Dakota in large hay bales used as winter feed by area cattle ranchers" (Platt et al. 2009:330). Certainly, this armadillo would have crossed parts of Nebraska where armadillos have not been reported, if it moved up from the south; however, other authors have hypothesized that in some areas armadillos are moving westward along Great Plains rivers (Merriam 2002). In Nebraska, the closest river would be the Niobrara, which runs just south of the South Dakota border.

Taulman and Robbins (2014) map more records in Nebraska based on a survey of biologists in areas along the expanding front of the species. Their records all fall within the area circumscribed by our specimen and photo-based data. Although Kansas is the probable source of armadillos entering Nebraska, there are no records from the northern tier of 13 counties in Kansas (Merriam 2002, Kaufman and Kaufman 2014, Taulman and Robbins 2014, Schmidt et al. 2018), and there are records from only five counties in the second tier of 13 northern counties—Pottawatomie (Kaufman and Kaufman 2014); Riley (Merriam 2002, Kaufman and Kaufman 2014); Rooks (Schmidt et al. 2018); Sheridan (Merriam 2002); Thomas (Schmidt et al. 2018).

All specimens from Nebraska for which the sex is known are males, including the four reported here. Our four specimens, respectively, had head and body lengths of 446, 402, 440, and 420. The weights (kg) of the first three males, respectively, were 6.1, 4.3, and 4.6. The testes of the specimen from Lincoln, Lancaster County measured 30 by 24. The capture dates for the four museum specimens were, respectively, 15 August, 8 February, 24 September, 30 June, and the dates of sightings were, respectively, 3 June, 24 July, 10 October, and 18 March. The male from Brock was reportedly found digging in a potato patch.

This uniquely dispersing population for a species of mammal of tropical origin has been the subject of a number of investigations attempting to predict the northern limit of this expansion. Taulman and Robbins (2014) revised their earlier prediction (Taulman and Robbins 1996) placing the northern limit of the breeding population near the -8° C isopleth for average minimum daily January temperatures in Kansas and Missouri. This isopleth crosses the eastern boundary of Kansas at about the level of Kansas City and proceeds directly west about three-quarters of the way across the state before turning sharply to the south. The isopleth exits Kansas across its southern border at the level of the eastern end of the Oklahoma panhandle. There is a female specimen in the collections of Emporia State University obtained at Ople, Lyon County, Kansas, on 28 July 1981 from near this hypothetical northern boundary for breeding populations. Taulman and Robbins (2014:1629) opined that another limiting factor would be ". . . persistent snow or ice cover that limits armadillo foraging opportunities and eventual starvation." Taulman and Robbins (2014) were in agreement with Humphrey's (1974) earlier estimation that 38 cm of annual precipitation was the limiting factor for westward expansion. This low annual rainfall occurs in only a few restricted areas in western Nebraska and Kansas. Feng and Papes (2015) performed an ecological niche

modeling analysis of the northward dispersal of armadillos and were in basic agreement with Taulman and Robbins (2014), but also attributed the expansion to "…the species' life-history traits, and frequent human-mediated introductions" (Feng and Papes 2015:806).

Feijó et al. (2019:266) attributed the northward expansion of nine-banded armadillo to "…its remarkable ecological plasticity." This plasticity was the result of the interplay of high phenotypic variation and high environmental tolerance. Feijó et al. (2019:266) found that "…armadillos from temperate open areas in North America are more omnivorous than tropical forms, which are more reliant on myrmecophagy." Loughry and McDonough (2013) summarized the dietary studies of *D. novemcinctus* in the United States, concluding that they were primarily insectivores taking a wide range of insects, especially coleopteran beetles. Other important dietary elements included earthworms, small vertebrates, and some plant material. The plant material is generally not further identified, but in coastal Georgia, Whitaker et al. (2012) found a variety of native fruits and fungi of the family Endogonaceae in stomachs of armadillos. Loughry et al. (2013) believed the relatively long life-expectancy of the nine-banded armadillo was another factor in their success, because individuals would experience multiple opportunities for breeding thus limiting the impact of a missed breeding season on the population dynamics.

The nine-banded armadillos in Nebraska at this time must be considered pioneering members of a northward expanding population. With no females being detected, there likely is no reproducing population in Nebraska. Northward movement of armadillos beyond the -8° C isopleth for average minimum daily January temperatures has been attributed to human-mediated introductions, but we are not in agreement with this hypothesis. While it is possible for this to occur, we do not feel this adequately accounts for the natural history of this species or patterns in these data. As we are likely only observing a subset of animals present in the region, it is unlikely that the significant numbers of armadillo required to sustain the numbers observed could be explained by chance individuals remaining confined in hay bales or other human created space for a trip from Texas/Oklahoma/Kansas to Nebraska. More inexplicable is that this is only occurring for male armadillos. This evidence indicates to us that a natural invasion is occurring, led by widely dispersing males (Arteaga et al. 2012) and outlines a need to better study armadillos in this region.

Nebraska and northern Kansas will be the site on which the next stage of this northward dispersal will play out and will allow for new insights in this understudied ecological process. The location and significance of the -8° C isopleth for average minimum daily January temperatures should be part of any study. It will be important that each individual armadillo found in Nebraska is more systematically monitored for sex and reproductive condition. When possible, the stomach contents of dead armadillos need to be collected and identified. These will be valuable data for determining the changing status of armadillo populations in Nebraska.

Myotis lucifugus lucifugus

Little brown bat

Specimens examined (2).—Pawnee Co.: Turkey Creek, 1 mi N, 2.8 mi E Lewiston P.O., T03N, R10E, Sec.6, SW1/4, NW1/4 [40.2560, -96.3477], 2 (UNSM ZM-29076, ZM-29078).

Remarks.—Our two specimens of little brown bat constitute the first record from Pawnee County (Czaplewski et al. 1979, Benedict 2004). This species has an unusual distribution in Nebraska with the nominate subspecies in the eastern third of the state and *M. l. carissima* in extreme western Nebraska in the Pine Ridge and North Platte River Valley (Jones 1964, Czaplewski et al. 1979, Geluso et al. 2013). During an acoustical survey, this species was detected at a number of localities across eastern Nebraska; however, White et al. (2016) did not detect calls of the little brown bat at their two stations in Pawnee County in the summers of 2012 and 2014.

Our specimens were lactating adult females netted on 22 June 2004 and weighed 7.5 and 8.0. Lactating females of this species have been taken in Johnson County on 24 June (Czaplewski et al. 1979), Sioux County on 15–16 July (Benedict 2004), and Scotts Bluff County on 28 May and 4 July (Geluso et al. 2013). These bats were taken in mist nets set over Turkey Creek in a Dry-Mesic Bur Oak Forest and Woodland community (Rolfsmeier and Steinauer 2010) dominated by bur oak (*Quercus macrocarpa*), green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), black walnut (*Juglans nigra*), mulberry (*Morus* sp.) and honey locust (*Gleditsia triacanthos*).

Myotis septentrionalis

Northern long-eared myotis

Specimens examined (7).—Dakota Co.: Old Missouri River channel, 1.1 mi S, 2.6 mi E Homer, T27N, R9E, Sec.20, NW1/4, NW1/4 [42.3040, -96.4410], 1 (UNSM ZM-28848). Holt Co.: Nebraska Public Power District property south of Spencer Hydro Plant, 5.1 mi S, 2 mi E Spencer P.O., T33N, R11W, Sec.30, SW1/4, SW1/4 [42.8046, -98.6569], 3 (UNSM ZM-29005–06, ZM-29185); Redbird WMA, 5.2 mi S, 1.8 mi E Lynch P.O., T32N, R10W, Sec.13, NW1/4, NE1/4 [42.7550, -98.4298], 1 (UNSM ZM-29183). Jefferson Co.: tributary of Big Sandy Creek *in* Alexandria

WMA, 1.8 mi W, 5 mi N Gladstone, T3N, R01E, Sec.17, NE1/4, NW1/4, 40.2342, -97.3406, 1 (UNSM ZM-29169). Pawnee Co.: 1 mi N, 2.8 mi E Lewiston P.O., on Turkey Creek, T03N, R10E, Sec.6, SW1/4, NW1/4 [40.2560, -96.3477], 1 (UNSM ZM-29077).

Remarks.—The northern long-eared myotis has been the subject of intensive study in Nebraska in recent years because the species is vulnerable to white-nose syndrome and listed as a federally threatened species (Geluso et al. 2015, 2018, 2019, Lemen et al. 2016a, Stein and White 2016, White et al. 2017a, 2017b, 2020, Brack et al 2019). Johnson and Geluso (2017) mapped the species occurring in 14 counties in the state, with the distribution in a rough crescent shape with records along the Niobrara River in the north as far west as Sheridan County, Missouri River in the east, and Republican River in the south to as far west as Harlan County (Johnson and Geluso 2017). We add records from four more counties—Dakota and Holt in the northeast, and Jefferson and Pawnee in the southeast. Although these records add to our understanding of northern long-eared bats in Nebraska, they fit within the existing crescent-shaped distribution. White et al. (2016) and Lemen et al. (2016b) using acoustical detection found northern long-eared myotis somewhat more widely distributed with records from 20 counties, including one site each in Dakota, Holt, and Jefferson counties.

In Holt County, one male was netted southeast of Lynch on 9 August 2004 and one male and two females southeast of Spencer on 12 August 2004. The bat from 9 August was caught over an old road near Louse Creek in a dry forest of bur oak, eastern red cedar (*Juniperus virginiana*), elm, and various shrubs. The animals caught on 12 August were taken over a small road between steep bluffs and the Niobrara River; vegetation included American basswood (*Tilia americana*), hophornbeam (*Ostrya virginiana*), American elm, hackberry (*Celtis occidentalis*), bur oak, plains cottonwood (*Populus deltoides*), willow (*Salix* sp.), boxelder (*Acer negundo*), and a few eastern red cedars. The two females were post-lactating. The females weighed 6.6 and 6.4, whereas the males weighed 6.1 and 6.3. In Dakota County, one adult male, weighing 6.5, was collected on 6 June 2004. Its testes measured 3 by 1.5 indicating it was not in reproductive condition. The bat was captured over an old river channel with a sand/silt bottom; vegetation included American elm, hackberry, ash, plains cottonwood, black walnut, boxelder, and a few bur oaks. The animal from Pawnee County was a lactating adult female taken on 22 June 2004, weighing 8.0. The Pawnee County site was on Turkey Creek on a stretch dominated by bur oak, green ash, American elm, black walnut, mulberry, and honey locust typical of the Dry-Mesic Bur Oak Forest and Woodland community (Rolfsmeier and Steinauer 2010). The animal from Jefferson County was an adult male with testes measuring 4 by 1.5 and weighing 7.1 when taken on 28 June 2004. The Jefferson County individual was caught over a spring-fed tributary of Big Sandy Creek with a sand and gravel bottom in an Eastern Riparian Forest community with a canopy of American elm, green ash, silver maple (*Acer saccharinum*), plains cottonwood, black walnut, hackberry, eastern red cedar, and honey locust (Rolfsmeier and Steinauer 2010). Geluso et al. (2019) found variability in reproductive timing for this species across Nebraska. Our female from Pawnee County was lactating in late June, which most closely matches females in east-central Nebraska. It is difficult to assess with which population the Holt County females fit because most females should be in post-lactation at this point (Benedict 2004, KN Geluso et al. 2004, Stein and White 2016).

This species has been treated as monotypic since van Zyll de Jong (1979) demonstrated that it was a species separate from *Myotis keenii*.

Eptesicus fuscus fuscus

Big brown bat

Specimens examined (8).—Dakota Co.: Old Missouri River channel, 1.1 mi S, 2.6 mi E Homer, T27N, R9E, Sec.20, NW1/4, NW1/4 [42.3040, -96.4410], 5 (UNSM ZM-28844-47, ZM-29215). Dundy Co.: Rock Creek Fish Hatchery, 5.4 mi N, 3 mi W Parks P.O., T2N, R40W, Sec.24, SE1/4 [40.1162, -101.7812], 1 (UNSM ZM-28950). Frontier Co.: Medicine Creek SRA, below dam, 40.3734, -100.2205, 1 (UNSM ZM-29039). Nuckolls Co.: Elk Creek in Harbine Park, Nelson, T3N, R7W, Sec.26, NE1/4, SW1/4, 40.1950, -98.0717, 1 (UNSM ZM-29170).

Remarks.—The big brown bat is one of the most common and widespread species of bat in Nebraska. Johnson and Geluso (2017) recorded the species from 36 counties in the state. Here we add four more counties to this list with records in the northeast from Dakota County, where the species was known in Dixon and Knox counties. In southwestern Nebraska, Dundy and Frontier counties are added where Serbousek and Geluso (2009) found this species also present in Chase and Red Willow counties. The other record is from further east in Nuckolls County along the Kansas border in south-central Nebraska.

In Dakota County, five bats were collected on 6 June 2004, with four of these being pregnant females. Each of these females carried two embryos, with one in each uterine horn, with crown-rump lengths of 9 to 33; the adult females weighed from 18.4 to 27.4. Additionally, one adult male, weighing 14.2, was captured in Dakota County; based on the size of its testes (5 by 3), it was not in reproductive condition. These bats were captured over an

old river channel with a sand/silt bottom; vegetation included American elm, hackberry, ash, plains cottonwood, black walnut, boxelder, and a few bur oaks. The individual from Nuckolls County was netted over Elk Creek at the south edge of Nelson on 29 June 2004. This site was a wooded riparian area with an overstory dominated by bur oak and hackberry but also had American elm, Siberian elm (*Ulmus pumila*), black walnut, mulberry, and eastern red cedar. To the north was the manicured part of Harbine Park and the town of Nelson, whereas to the south were hay fields. This individual was a male flying young of the year, with testes measuring 5 by 2 and weighing 12.2. The presence of a newly flying young bat suggests there was a maternity colony in this area. The specimen from Dundy County was netted over Rock Creek at the Rock Creek Fish Hatchery on 11 July 2004; vegetation included Siberian elm, plains cottonwood, and eastern red cedars. This individual was a flying young of the year female that weighed 13.7 when captured. The bat from Frontier County was a non-pregnant female when captured on 15 September 2007 by Keith Geluso. The bat weighed 22. This bat was netted on Medicine Creek just below the dam forming Harry Strunk Lake. Females of this species in Nebraska are pregnant between 4 May and 14 July and lactating from 31 May to 5 September, so it is no surprise that the September female showed no reproductive activity (Czaplewski et al. 1979, Benedict 2004, KN Geluso et al. 2004).

We have followed Hoffman and Genoways (2008) in applying the nominate subspecies to all of these records. The specimens from Dundy and Frontier counties come from a broad zone of intergradation between *E. f. fuscus* to the east and *E. f. pallidus* to the north and west. The specimen from Nuckolls County is from well within the geographic range of *E. f. fuscus*.

Lasionycteris noctivagans

Silver-haired bat

Specimen examined (1).—Dakota Co.: Old Missouri River channel, 1.1 mi S, 2.6 mi E Homer, T27N, R9E, Sec.20, NW1/4, NW1/4 [42.3040, -96.4410], 1 (UNSM ZM-28850).

Remarks.—Silver-haired bats have been taken across Nebraska, but there are no previous records from Dakota County (Johnson and Geluso 2017). These bats are migratory in Nebraska moving north in spring and south in autumn, and based on the migratory pattern described by K Geluso et al. (2004), this female taken on 6 June 2004 may still have been migrating northward. However, growing evidence indicates that some individuals remain in Nebraska in summer and produce young (Benedict 2004, K Geluso et al. 2004, KN Geluso et al. 2004, Geluso and Geluso 2016). The bat was captured over an old river channel with a sand/silt bottom; vegetation included American elm, hackberry, ash, plains cottonwood, black walnut, boxelder, and a few bur oaks. The female weighed 15 and carried two embryos with one in each uterine horn, measuring 16 in crown-rump length. Twins in silver-haired bats have been reported previously in Nebraska (K Geluso et al. 2004, Geluso et al. 2013). This species is considered to be monotypic.

Nycticeius humeralis humeralis

Evening bat

Specimens examined (3).—Richardson Co.: Indian Cave State Park, T3N, R16E, Sec.1, NW1/4, 40.2576, -95.5685, 3 (UNSM ZM-29040, ZM-29043, ZM-29949).

Remarks.—Jones (1964) reported the evening bat from only one site in Butler County, but Johnson and Geluso (2017) report the species from 19 counties in the state. Part of the changing distribution of evening bats in Nebraska is due to more extensive sampling, but we believe it also is the result of range expansion as evening bats move westward along the Republican, Platte, and Niobrara rivers with increasing riparian forests (Benedict et al. 2000, Benedict 2004, KN Geluso et al. 2004, Geluso et al. 2008, Serbousek and Geluso 2009, Andersen et al. 2017). We document here a twentieth county—Richardson—in extreme southeastern Nebraska to the places where evening bats are known, although Brack et al. (2019) recorded the species from the county based on capture/release specimens. Evening bats are migratory in Nebraska, with the earliest arrival date reported being 30 April (Serbousek and Geluso 2009) and the latest date present being 6 October (Geluso et al. 2008). The Nebraska populations consist solely of adult females and flying young of the year after 23 June (Serbousek and Geluso 2009).

Our three specimens are adult females evincing no gross reproductive activity taken on the following dates: 20 June 2007, 21 August 2007, and 8 September 2007. The females from August and September were not expected to be reproductively active because the period of lactation in Nebraska is 15 June until 24 July (Benedict 2004, Serbousek and Geluso 2009). The lack of reproductive activity in the female netted on 20 June, however, was unexpected, indicating she was either not pregnant when migrating to Nebraska or lost her young. The June and August females weighed 6.5 and 9.5.

Perimyotis subflavus subflavus

Tricolored bat

Specimen examined (2).—Dakota Co.: Old Missouri River channel, 1.1 mi S, 2.6 mi E Homer, T27N, R9E, Sec.20, NW1/4, NW1/4 [42.3040, -96.4410], 1 (UNSM ZM-28852). Lancaster Co.: Robbers Cave, 9th Street and Robbers Cave

Road, Lincoln [40.7799, -96.7075], 1 (UNSM ZM-31042).

Remarks.—Johnson and Geluso (2017) reported tricolored bats in seven counties based on specimen records. We add two counties to this list—Dakota and Lancaster. Most records for this species are in eastern Nebraska, but in recent years records from further west have been reported in Buffalo, Cherry, and Greeley counties. White et al. (2016) conducting an audio survey found that the tricolored bat probably is more widely distributed in eastern Nebraska than indicated by specimen records. At a site north of Homer on Omaha Creek in Dakota County (41.717154, -96.702515), they believed that they documented the tricolored bat by audio readings. They also had three sites along Salt Creek in Lancaster County where they believed the species was present based on audio readings—where Waverly Road crosses the creek near Waverly (40.9286, -96.5497) and two areas very close to where Old Cheney Road crosses the creek in Lincoln (40.7569, -96.7170).

In Dakota County, one adult female, weighing 6.0, was collected on 6 June 2004. This bat was pregnant, carrying one embryo (crown-rump length 6) in its left uterine horn. The bat was captured over an old river channel with a sand/silt bottom; vegetation included American elm, hackberry, ash, plains cottonwood, black walnut, boxelder, and a few bur oaks. Our specimen from Lancaster County was obtained while roosting in Robbers Cave in Lincoln. This was a small natural cave that was enlarged to ≈5000 square feet in the 1890s. The cave has been accessible to visitors off and on since that time—most recently the cave was used as a storage area for a local craft beer brewery. Individuals of *M. septentrionalis* also have been found using this cave. Tricolored bats are known to occupy other caves and mines in Nebraska, especially for winter hibernation (Damm and Geluso 2008). Our specimen was an adult female taken 15 May 2013 by Patricia Freeman. This female weighed 6.0.

We use the scientific name *Perimyotis subflavus* for this species long known as *Pipistrellus subflavus*; genetic studies have demonstrated that this species is not related to Old World members of the genus *Pipistrellus* and represent a separate evolutionary lineage (see Hoofer and Van Den Bussche 2003 and Roehrs et al. 2010 for summaries of these studies).

Lasiurus borealis

Eastern red bat

Specimens examined (8).—Dakota Co.: Old Missouri River channel, 1.1 mi S, 2.6 mi E Homer, T27N, R9E, Sec.20, NW1/4, NW1/4 [42.3040, -96.4410], 3 (UNSM ZM-28851, ZM-28853–54). Gage Co.: Bloody Run Creek, 2.6 mi S, 6.25 mi W Virginia P.O., T3N, R7E, Sec.22, SE1/4, SE1/4 [40.2066, -96.6156], 1 (UNSM ZM-29075). Lincoln Co.: Chester Island WMA, 2 mi S, 1 mi W Brady [41.0555, -100.5441], 1 (UNSM ZM-29899). Nemaha Co.: Indian Cave State Park, 40.2687, -95.5699, 1 (UNSM ZM-29882); Whiskey Run Creek, 2.7 mi S, 0.1 mi W Nemaha P.O., 40.3129, -95.6755, 2 (UNSM ZM-28904–05).

Remarks.—Johnson and Geluso (2017) summarize the distribution of the eastern red bat across Nebraska with records from 46 counties. We add four counties to this list—Dakota, Gage, Lincoln, and Nemaha—so that the species is known from more than one half of the state's 93 counties. The individuals from Dakota County are from northeastern Nebraska where the species has been previously recorded in Dixon County (Benedict 2004). The records from Gage and Nemaha counties essentially fill areas in southeastern Nebraska where records were missing. The Lincoln County individual is from the south side of the Platte River and ≈15 mi upstream from Gothenburg, Dawson County, where Johnson and Geluso (2017) reported three individuals. This a migratory species with bats entering the state from the south and east based on records in the state from 26 April to 1 November (Jones 1964, Czaplewski et al. 1979, Benedict 2004, KN Geluso et al. 2004, Geluso and Geluso 2016).

In Dakota County, two pregnant females and one adult male were captured on 6 June 2004. The females carried three (one left, two right) or four embryos (two left, two right), ranging in crown-rump length from 20 to 21; the adult females weighed 17.6 and 18.8, respectively. The male weighed 10.0, and its testes measured 4 by 2 indicating it was not in reproductive condition. The bats were captured over an old river channel with a sand/silt bottom; vegetation included American elm, hackberry, ash, plains cottonwood, black walnut, boxelder, and a few bur oaks. The bat from Gage County was an adult female, which was lactating when captured on 21 June 2004, and weighing 13.5. This bat was netted over Bloody Run Creek under a large American elm with bur oak, hackberry, honey locust, black walnut, green ash, and eastern red cedar also common at the netting site. The female from Indian Cave State Park was lactating when captured on 20 June 2004 and weighed 12.4. It was taken over a paved road passing through mature forests of northern red oak (*Quercus rubra*), red mulberry (*Morus rubra*), chinquapin oak (*Quercus muehlenbergii*), pawpaw (*Asmina triloba*), American elm, sycamore (*Platanus occidentalis*), plains cottonwood, black walnut, and some large willows. The other two individuals from Nemaha County were taken along Whiskey Run Creek on 26 June 2004. One individual was an adult female showing no gross reproductive activity and weighing 12.3, whereas the other bat was an adult male with greatly reduced testes and

weighing 11.5. These bats were taken over an entrenched creek lined with black walnut, honey locust, ash, American elm, and white mulberry (*Morus alba*). The bat from Lincoln County was an adult male weighing 11.0, with testes 2 in length on 8 August 2006. This bat was taken by Justin Hoffman in Chester Island Wildlife Management Area near the Platte River.

This species has been considered monotypic since the work of Baker et al. (1988) showed that western and eastern populations of red bats were distinct species (see also Bogan and Williams 1970, Schmidly and Hendricks 1984). The Nebraska populations are clearly associated with the eastern red bat as the closest that the western red bat approaches the state is northern Utah (Solick et al. 2020).

Aeorestes cinereus

North American hoary bat

Specimen examined (3).—Dakota Co.: Old Missouri River channel, 1.1 mi S, 2.6 mi E Homer, T27N, R9E, Sec.20, NW1/4, NW1/4 [42.3040, -96.4410], 2 (UNSM ZM-28849, ZM-28855). Richardson Co.: Indian Cave State Park, 40.2576, -95.5685, 1 (UNSM ZM-29947).

Remarks.—Our specimens of the North American hoary bat from Dakota County are from northeastern Nebraska where the species was previously recorded in Dixon County. Our record from Richardson County begins to fill a five-county gap in the known distribution of the species in southeastern-most Nebraska. Counties still missing records of this bat from this region are Johnson, Nemaha, Otoe, and Pawnee (Johnson and Geluso 2017).

In Dakota County one lactating female, weighing 27.1, was collected on 6 June 2004; it carried no embryos. A second female also was captured but no notes were taken on reproductive condition; this bat weighed 28.2. These bats were captured over an old river channel with a sand/silt bottom; vegetation included American elm, hackberry, ash, plains cottonwood, black walnut, boxelder, and a few bur oaks. The specimen from Richardson County was a non-pregnant female taken on 8 September 2007 by Patricia Freeman and Cliff Lemen. This migratory species remains in Nebraska until October, but reproduction is completed by at least early August (Czaplewski et al. 1979, Benedict 2004, K Geluso et al. 2004, Geluso and Geluso 2016).

This species has been known under the scientific name of *Lasiurus cinereus* for many years, but recent molecular studies have shown that the relationships of members of the genus *Lasiurus* are best represented by dividing them into three genera—red (*Lasiurus*), hoary (*Aeorestes*), and yellow (*Dasypterus*) bats. Another result of these studies is treating *A. cinereus* as monotypic (Baird et al. 2015, 2017), although debate on this taxonomic interpretation is ongoing (see Ziegler et al. 2016, Novaes et al. 2018).

Tamias striatus griseus

Eastern chipmunk

Specimens examined (2).—Richardson Co.: Rulo Bluffs Preserve, 2.2 mi S, 4.4 mi E Rulo, 40.0229, -95.3496, 1 (UNSM ZM-28899); Bluffs at jct. of Missouri & Big Nemaha rivers, 2.3 mi S, 2.9 mi E Rulo P.O., 40.0262, -95.3766, 1 (UNSM ZM-28903).

Remarks.—This species is associated with eastern oak-hickory deciduous forests and as such, the species is at the extreme western edge of its geographic range along the bluffs on the western side of the Missouri River. This species was known from the vicinity of the Engineer Cantonment in extreme southern Washington County just north of the Douglas County line in the early 1820s (Genoways and Ratcliffe 2008, Genoways et al. 2019, Genoways and Labedz 2019). There have been only a few scattered sightings along the Missouri River in recent decades and none north of Omaha. Although our specimens are within the known geographic distribution of this species as outlined by Jones (1964), these are the first reported captures since the 1950s. This is a vulnerable species in Nebraska and its future is dependent on maintenance of remnant oak-hickory forests. These forests have been heavily impacted over the last 150 years by lumbering, droughts, river channelization, suppression of fire, succession and introduction of species leading to changes in species composition and historic community dynamics less suitable for *T. striatus* success (Benedict et al. 2000, Rolfsmeier and Steinauer 2010). With climate change, this forest community and associated chipmunks will face new threats.

On 22 and 25 June 2004, we caught three eastern chipmunks in Sherman traps in wooded bluffs along the Missouri River in Richardson County (one individual was released). All three individuals were caught near abandoned buildings and storm cellars. The chipmunk from Rulo Bluffs Preserve, taken on 22 June, was an adult female evincing no gross reproductive activity and weighing 134.5. This animal was caught next to an old storm cellar in a deep ravine with mature, diverse forests of sycamore, American basswood, hophornbeam, chinquapin oak, ash, American elm, and pawpaw. The other individual was an adult male with testes measuring 10 by 5 and weighing 119.4. It was trapped in the bluffs above the Big Nemaha River near an old shed that was roofed over by trees including American elm, ash, black walnut, hackberry, and eastern red cedar. We follow Jones (1964) in applying the subspecific name *T. s. griseus* to Nebraska populations, which is the taxon occupying large portions of Iowa, Illinois, Minnesota, and Missouri.

Sciurus niger rufiventer
Eastern fox squirrel

Specimen examined (1).—Kimball Co.: Oliver Reservoir State Recreation Area, T15N, R57W, Sec.35, NE1/4 [41.2295, -103.8244], 1 (UNSM ZM-28969).

Remarks.—The westward movement of the eastern fox squirrel across the Great Plains has been well documented (Jones 1964, Maxwell and Brown 1968, Choate 1987, Geluso 2004, Platt et al. 2009, Buskirk 2016). This movement has been aided by the maturation of riparian forests along the west-to-east flowing rivers and introductions by humans. In Nebraska, the areas without a documented record by Jones (1964) were the counties in the Panhandle south of the North Platte River. Our specimen taken at Oliver Reservoir in Kimball County on 14 July 2004 fills this void. We have no knowledge of how this population arrived in this part of Nebraska; there have been introductions into city parks and other natural areas in Nebraska and to the west in Wyoming from which the species later dispersed (Jones 1964, Buskirk 2016). If fox squirrels reached this area by natural dispersal, it most likely would have occurred along Lodgepole Creek. The nearest record in Nebraska along Lodgepole Creek lies ≈105 mi [169 km] to the east where an individual was documented along the South Platte River 5 mi WSW Ogallala, Keith County. Our specimen was a young adult male obtained in a campground area in an open cottonwood grove with sparse, mowed grasses underneath.

Perognathus fasciatus fasciatus
Olive-backed pocket mouse

Specimens examined (2).—Cheyenne Co.: 16.3 km S, 0.5 km E Potter, 41.0706, -103.3061, 2 (UNSM ZM-30060–61).

Remarks.—Jones (1964:164) reported olive-backed pocket mice from five counties in western Nebraska, primarily in the northwestern Panhandle (Dawes, Sheridan, and Sioux) and adjacent Cherry County. He had only one record from the southwestern Panhandle from near Oshkosh in Garden County. Subsequently Williams and Genoways (1979) added records from Banner and Kimball counties confirming a broader distribution in the southwestern Panhandle. The two specimens reported here are the first to be reported from Cheyenne County, leaving Box Butte, Deuel, Morrill, and Scotts Bluff as the only counties in the Panhandle where this species has not been recorded. These are mice of the short-grass prairies of the High Plains of western Nebraska and have not been reported from the adjacent Sand Hills region (Jones 1964, Manning and Jones 1988).

The specimens examined were both non-pregnant females trapped by Keith Geluso on 30 September 2010. They weighed 9.5 and 10.0. Neiswenter and Riddle (2011) found more genetic diversity in species of the *P. fasciatus* group than revealed by morphologic studies, but they did not draw any systematic conclusions from their research. We, therefore, have followed Williams and Genoways (1979) in assigning Nebraska specimens to the nominate subspecies.

Perognathus flavescens flavescens
Plains pocket mouse

Specimen examined (1).—Sioux Co.: Gibbs Ranch, 26 mi N, 1.6 mi E Henry [*in* Scotts Bluff Co.] P.O., T28N, R57W, Sec.30, NE1/4 [42.3729, -104.0176], 1 (UNSM ZM-28977).

Remarks.—Jones (1964:167) mapped the distribution of the plains pocket mouse as being statewide with the exception of the extreme northwestern Panhandle and the counties in eastern Nebraska along the Missouri River. Geluso and Wright (2012) conducted an intensive study of the boundary between western and eastern subspecies in east-central Nebraska and reported the first record from Douglas County on the eastern border of the state. Our specimen partially fills the gap in the known distribution of the plains pocket mouse being from Sioux County, the northwestern-most county in the state. This site is ≈35 mi northwest of the previous western-most location, 8 mi NNW Scottsbluff, Scotts Bluff County (Jones 1964).

This individual was an adult male with testes measuring 4 by 2. It was taken in a pitfall trap on 27 July 2004, weighing 9.8. The site of capture was a flat, sandy pasture at the base of sandstone bluffs; vegetation included grama (*Bouteloua* sp.), prairie sagewort (*Artemisia frigida*), dropseed (*Sporobolus* sp.), sandreed (*Calamovilfa* sp.), soapweed yucca (*Yucca glauca*), prickly pear, and many forbs as well as many areas of bare soil. In the Panhandle *P. flavescens* occurs in the same general areas as *P. fasciatus*, but the former prefers areas of sandy or sandy-loam soils, whereas the latter occurs in areas of harder soils (Monk and Jones 1996). We have followed Jones (1964) and Geluso and Wright (2012) in assigning plains pocket mice from western Nebraska to the nominate subspecies.

Thomomys talpoides cheyennensis
Northern pocket gopher

Specimens examined (14).—Kimball Co.: State Line Road, 8 mi W Bushnell P.O., T15N, R59W, Sec.35, NE1/4, NE1/4 [41.2340, -104.0455], 3 (UNSM ZM-28971–73); State Line Road, 7 mi S, 5 mi W Bushnell P.O., T13N, R58W, Sec.5, NE1/4, NE1/4 [41.1332, -103.9905], 7 (UNSM ZM-28961–66, ZM-29217); 1.0 mi S, 7.75 mi W Kimball, Oliver Reservoir State Recreation Area, 41.2167, -103.822, 2 (UNSM ZM-17161–62); Hwy 71, 5.7 mi S Kimball P.O., T14N, R55W, Sec.29, NW1/4, SW1/4 [41.1546, -103.6615], 2 (UNSM ZM-28974, ZM-29218).

Remarks.—Swenk (1941) described this new subspecies from the two southwestern-most counties in the Nebraska Panhandle. He had available for study six specimens from a total of four sites in Cheyenne and Kimball counties and placed the type locality at 2 mi S Dalton, Cheyenne County. Swenk (1941:7) stated that these pocket gophers occupied areas ". . . of soils of the Rosebud series . . . of Kimball, southern Banner and western Cheyenne counties. . . ." Subsequently, Fichter (1941) added a record from an unspecified site in Banner County based on bones recovered from an owl pellet, Jones (1964) added a record from Smeed, Kimball County, based on an individual trapped in 1957, and Thaeler (1980) reported three specimens from 7.7 mi S Kimball, Kimball County. Under additional records, Jones (1964:154) listed one locality in Cheyenne County and two in Kimball County based on an unpublished manuscript by Swenk, which we have been unable to locate. Given this circumstance, it is impossible to judge the basis of these observations or to assess their scientific value. We are aware of no other published records of this subspecies from sites in Nebraska, but it has been recorded from the vicinity of Pine Bluff, Laramie County, Wyoming, just to the west of Kimball County (Bailey 1915, Long 1965). Based on this limited number of localities, available specimens, and geographic range, Benedict et al. (2000) questioned the future status of this taxon in Nebraska. However, as our records indicate, we have taken *T. t. cheyennensis* at five new localities in Kimball County and these pocket gophers appear to be reproducing and thriving in these areas. Future work on the status of this taxon should include a survey of its geographic range in Banner, southwestern Morrill, and eastern Cheyenne counties.

The seven pocket gophers taken south and southwest of Bushnell on 15 July 2004 included three adult males and four adult females. None of the female evinced any gross reproductive activity. One male had testes that measured 4 by 4. Three of the females weighed 103.8, 104.2, and 98.0, whereas the three males weighed 86.4, 100.7, and 102.0. These gophers were trapped on the flat tableland to the south of Lodgepole Creek; vegetation at the site consisted of dry prairie, including needle and thread (*Hesperostipa* sp.), grama, three-awn (*Aristida* sp.), soapweed yucca, prickly pear, and many forbs. All three individuals taken on 16 July 2004 west of Bushnell were young/subadults (2 males, 1 female) collected on the prairie-covered table north of Lodgepole Creek; vegetation included needle and thread, soapweed yucca, cheatgrass (*Bromus tectorum*), grama, prickly pear, and many forbs. The weights of these gophers were, respectively, 77.9, 68.7, and 41.5. Our two specimens from south of Kimball taken on 17 July 2004 were a young male and a subadult female, weighing, respectively, 50.3 and 79.2. These animals were caught along Highway 71 in thin, rocky soil covered by disturbed prairie vegetation including crested wheatgrass (*Agropyron cristatum*) and many annual and perennial forbs. The specimens from Oliver Reservoir included a subadult and a young female taken on 20–21 July 1988 by Dudley Friskopp, respectively, weighing 78.6 and 48.9.

Thomomys t. cheyennensis shares a diploid number, 2N = 48, with *T. t. pierreicolus* from the extreme northwestern corner of the Panhandle (see account of that taxon for details). However, at least in modern times, these two Nebraska subspecies have not been in contact, but are connected through a series of populations in northeastern Colorado and eastern Wyoming (Hall 1981). In Nebraska, the geographic ranges of these subspecies are separated at least by the Wildcat Hills and the North Platte River Valley. Based on Jones (1964) and our own experience, the valley is occupied by *Geomys lutescens* with no records of the northern pocket gopher being present.

Thomomys talpoides pierreicolus

Northern pocket gopher

Specimens examined (4).—Dawes Co.: pasture east of Highway 2/71, 8.1 mi N, 0.4 mi E Crawford P.O., T33N, R52W, Sec.26, NE1/4 [42.8096, -103.4080], 1 (UNSM ZM-28995). Sioux Co.: Oglala National Grassland, east shoulder Edgemont Road, 18.5 mi N, 0.3 mi E Harrison P.O., T34N, R56W, Sec.1, NW1/4, NW1/4 [42.9562, -103.8732], 1 (UNSM ZM-28986); Oglala National Grassland, west shoulder Edgemont Road, 15.1 mi N Harrison P.O., T34N, R56W, Sec.23, NW1/4, SE1/4 [42.9057, -103.8835], 1 (UNSM ZM-28994); T35N, R53W, Sec.35, SE1/4 [along Highway 71/2, ≈8 mi N Joder; 42.9624, -103.5293], 1 (UNSM ZM-21528).

Remarks.—Swenk (1941) described this subspecies of pocket gopher based on 10 specimens from four localities in northern Sioux and Dawes counties, with the type locality being Wayside, Dawes County. Swenk (1941:3) believed that pocket gophers of this taxon were confined to the ". . . soils of the Pierre series, including the Pierre clay and loam." He extended the geographic range of this subspecies into western South Dakota, eastern Wyoming, and southeastern Montana where these soils occur (Swenk 1941). In Nebraska, there have been subsequent reports of these pocket gophers from the vicinity of the type locality, but no new localities have been documented (Jones 1964, Thaeler 1980). Our records add three new localities in Sioux County and one new locality in Dawes County. The previous record of the northern pocket gopher in Sioux County was based on a single skull "picked up in a dry wash along Indian Creek" north

of Story (Swenk 1941:1). Our two specimens from north of Harrison lie a short distance to the east and southeast of the original site in Sioux County. Our third specimen is from the extreme northeastern corner of the county, filling the gap between the other Sioux County localities to the west and the type locality 20 mi to the east. The new record north of Crawford in Dawes County is from a little more than 2 mi south-southeast of Swenk's locality of Sand Creek Valley near Horn, and this record is the southernmost for the subspecies. Benedict et al. (2000) questioned the future of this pocket gopher in Nebraska, but these records would indicate that the taxon is still present and probably more widespread than formerly anticipated. Because of the restricted geographic range of this taxon in Nebraska, its status will remain vulnerable and should be periodically monitored.

The two specimens from north of Harrison were adult females, with the northernmost being a female taken on 31 July 2004 weighing 61.9, whereas the other displayed no gross reproductive activity when taken on 1 August 2004, weighing 64.8. The gophers from 31 July and 1 August were captured adjacent to a gravel road, in hard, rocky soil; the sparse vegetation included grama, threeawn, junegrass (*Koeleria macrantha*), smooth brome (*Bromus inermis*), cheatgrass, prickly pear, and many forbs. Two pieces of scurf pea (*Pediomelum* sp.) stem were found in the gopher's tunnel on 31 July, each measuring 8 to 12 cm long. The third individual from Sioux County was unsexed by the collector J. O'Brien when it was captured on 12 June 1976. The specimen from Dawes County was a non-pregnant female weighing 66.1 when taken on 3 August 2004. This animal was caught on a flat shelf with hard soil above a dry wash, on the shoulder of a state highway; vegetation included grama, buffalo grass (*Bouteloua dactyloides*), prickly pear, and many forbs.

Thaeler (1980) reported a diploid number of 2N = 48 for four individuals from near the type locality. Of the 32 *T. talpoides* subspecies studied by Thaeler (1980), this diploid number was only found in four others—*cheyennensis* from Kimball County, Nebraska; *talpoides* from Saskatchewan, Canada; *trivialis* from Sweet Grass County, Montana; and some of eight individuals of *nebulous* from the Black Hills of South Dakota, whereas other individuals in the Black Hills population had 2N = 46. Studies of their subspecific status need to be expanded to include more populations of *T. talpoides* and intensive investigations are needed at the contact zone of these chromosomal types. We maintain the subspecies designation of *T. t. pierreicolus* for this population of pocket gophers in Nebraska.

Neotoma floridana attwateri

Eastern woodrat

Specimens examined (4).—Gage Co.: 0.55 mi S, 0.6 mi W Holmesville, T3N, R7E, Sec.31, NE1/4, NE1/4 [40.1883, -96.6738], 1 (UNSM ZM-29308). Pawnee Co.: 4.35 mi S, 2 mi E Liberty [*in* Gage Co.] P.O., T01N, R09E, Sec.29, W1/4, SW1/4, 40.1896, -96.6731, 3 (UNSM ZM-29079–81).

Remarks.—The eastern woodrat is represented by three subspecies in Nebraska—*N. f. baileyi* along the Niobrara River (Graham et al. 2012); *N. f. campestris* in southwestern Nebraska (Kugler and Geluso 2009, Wills et al. 2011); and *N. f. attwateri* in southeastern Nebraska, first reported by Clausen (1999). Clausen (1999) reported this subspecies from four sites in southern Gage and Jefferson counties in southeastern Nebraska, and Benedict et al. (2000) reported specimens from a third site in southern Gage County. Our field studies have expanded the known distribution of *N. f. attwateri* in this area of Nebraska adding a site in a third county—Pawnee. The new locality near Holmesville in Gage County is the northern-most place from which this subspecies is known, but the distance is only ≈7 mi further north than earlier captures. These records together with earlier ones show that this subspecies of the eastern woodrat is well established in drainages of the Big Blue and Little Blue rivers in Nebraska and may have a broader distribution in the state than current records reveal.

All of our four specimens were females obtained by trapping around middens. The specimen from southwest of Holmesville was a juvenile taken on 25 June 2004 from a midden in eastern riparian forest between S 36 Road and the Big Blue River and dominated by cottonwood, green ash, hackberry, mulberry, and American plum (*Prunus americana*). One of the specimens from Pawnee County was a lactating female that revealed a single placental scar in each uterine horn when obtained on 23 June 2004. The other two females from this site were both subadults taken on the same date as the adult. The three Pawnee County specimens came from a series of three middens in the eastern borrow ditch of 607 Avenue dominated by green ash, black walnut, Osage orange (*Maclura pomifera*), and bur oak, with brushy understory dominated by smooth brome. The adult female was trapped outside the northern-most midden ≈40 m south of Mission Creek. A male was captured (no specimen taken) from the next midden 20 m south of the first midden and the two subadults were trapped from the third midden 20 m south of midden 2. The body weights of the three woodrats from Pawnee County were, respectively, 250, 140, and 120. All three Pawnee County specimens had internal molt patterns with the adult female's pattern running the entire length of the back and both juveniles with internal molt

only on the head. We follow Birney (1973) and Benedict et al. (2000) in applying the subspecific name *N. f. attwateri* to this population of woodrats.

Onychomys leucogaster arcticeps

Northern grasshopper mouse

Specimens examined (4).—Cedar Co.: 3.6 mi W Hartington, 42.6127, -97.3392, 1 (UNSM ZM-29404). Merrick Co.: 3 mi N, 2.5 mi E Silver Creek, 41.3589, -97.6175, 1 (UNSM ZM-29376). Pierce Co.: 5 mi S, 15 mi W Pierce, 42.1271, -97.8150, 2 (UNSM ZM-29892–93).

Remarks.—Jones (1964) showed northern grasshopper mice occurring throughout Nebraska except for the eastern-most counties along the Missouri River. He applied two subspecific names to these populations, with *O. l. arcticeps* in the western two-thirds of the state and *O. l. breviauritus* in the eastern one-third. Subsequently, Engstrom and Choate (1979; see also Riddle and Choate 1986) reviewed this species, placing all Nebraska grasshopper mice in the subspecies *O. l. arcticeps*, which is the arrangement followed here. Genoways and Choate (1970) and Benedict et al. (2000) documented the species occupying three of the eastern-most counties in the southeastern part of the state—Otoe, Cass, and Richardson. Huebschman et al. (2000) reported records of grasshopper mice in southeastern Nebraska in Nemaha County and Cedar County in the northeast based on remains recovered from owl pellets. Here we add specimen records for Cedar County and the first records for Pierce County in northeastern Nebraska and Merrick County in the central part of the state. It has been proposed that these new records in counties along the Missouri River result from an eastward movement by northern grasshopper mice populations. This hypothesis is strengthened by a similar expansion in Iowa, from northwestern Iowa where it was first reported to geographic areas east and south in this state (Bowles et al. 1998, Rickert and Geluso 2010). The expansion of the northern grasshopper mouse has been attributed to the replacement of formally forested areas with agricultural fields and roadside right-of-ways (Fleharty and Navo 1983, Benedict et al. 2000, Rickert and Geluso 2010, Spanel and Geluso 2018).

Three of the female mice captured were pregnant with the following number of embryos (crown-rump length) on these dates: Cedar County—4, 3R, 1L (15) 15 July 2008; Merrick County—4, 2R, 2L (6) 8 July 2008; Pierce County—5, 3R, 2L (12) 25 June 2005. The other specimen from Pierce County was an adult male with testes measuring 24 by 13. The three females weighed, respectively, followed by the male: 37, 34, 46, 46.5.

The mice from Cedar and Merrick counties were obtained by Keith Geluso and the Pierce County mice were trapped by Justin Hoffman. The trap site in Cedar County was along a roadside ditch though dry sandy soil adjacent to a heavily grazed pasture. Plants included smooth brome, cheatgrass, ragweed (*Ambrosia* sp.), plantain (*Plantago* sp.), rose (*Rosa* sp.), and leadplant (*Amorpha canescens*). Traps were placed in sandy roadside ditches in Merrick County because the local vegetation was confined primarily to a 7 m wide strip along the road. The vegetation was dominated by cheatgrass, western wheatgrass (*Pascopyrum smithii*), sunflowers (*Helianthus* sp.), and ragweed. In Pierce County, traplines also were placed in sandy roadside ditches along a low maintenance road where the vegetation was primarily smooth brome and poison ivy (*Toxicodendron radicans*). The road was lined by a shelterbelt composed primarily of plains cottonwoods with a cornfield on the other side.

Sigmodon hispidus texianus

Hispid cotton rat

Specimens examined (2).—Jefferson Co.: 703rd Road, between Lima Avenue (to the west) and 572nd Avenue, 40.0159, -97.1133, 1 (UNSM ZM-29993). Lincoln Co.: 4 mi S, 1 mi W North Platte, Indian Hills subdivision, T13N, R30W, Sec.20, SW1/4, 41.0809, -100.7871, 1 (UNSM ZM-31038).

Remarks.—The northward movement of the hispid cotton rat from Kansas into Nebraska has been well documented since their first capture on 16 November 1958 along a branch of the Nemaha River southwest of Dawson, Richardson County in southeastern-most Nebraska (Jones 1964). The next reported record was in Adams County in south-central Nebraska (Genoways and Schlitter 1967, Genoways and Choate 1967). Farney (1975) conducted extensive trapping in south-central Nebraska and added four counties (Franklin, Harlan, Kearney, and Webster) with material from Kearney County being the furthest north. Wright et al. (2010), after two years of field studies in south-central and southwestern Nebraska, added seven counties (Chase, Dundy, Furnas, Hayes, Hitchcock, Nuckolls, and Red Willow) and 13 new localities to the geographic range of the species in Nebraska. The northern-most point in the movement of the hispid cotton rat stood at a place in northeastern Hayes County, and the Nuckolls County record reduced the gap between the central Nebraska records and the Richardson County site to four counties along the Kansas border (Wright et al. 2010). Wills et al. (2011) added two counties (Gosper and Phelps) in central Nebraska to the known distribution. Finally, between 30 September and 3 October 2014 nine hispid cotton rats were trapped within a patch of common reed (*Phragmites australis*) that measured 0.16 ha on Jeffery Island (40.6820, -99.5663) in southeastern Dawson

County (Frisch et al. 2015). These captures represented the northern-most record in Nebraska for the hispid cotton rat and the first record north of a Platte River channel in Nebraska. One proposal had been that the Platte River could present a barrier to the continued northward movement of this species, but given the river's low flows in some years the hispid cotton rat appears capable of overcoming this obstacle.

Our two records continue to document the expanding geographic range of *S. hispidus* in Nebraska. The individual from Jefferson County begins closing a gap in the distribution of populations in southeastern parts of the state along the Nebraska-Kansas border. The original Nebraska collecting site was in Richardson County, the southeastern-most county of the state, with no previous records in the four counties to the west. Jefferson County is the third county, counting toward the west, with Gage and Pawnee counties intervening without records of hispid cotton rats to date. The specimen from Lincoln County, on the south edge of North Platte, is the northwestern-most for the species in North America, being 65 mi northwest of the site in Dawson County and 30 miles north of the record in Hayes County. These more recent records demonstrate the species is still moving northward, but the geographic range also seems to be moving to the west. Obviously, monitoring of the status and movements of hispid cotton rats will need to be continued in Nebraska.

The Jefferson County individual was obtained by Cliff Lemen on 4 October 2003 at a place ≈1 mile north of the Kansas-Nebraska border [0.8 mi S, 5 mi W Steele City]. This hispid cotton rat was an adult male with testes measuring 7 by 4 and weighing 55.8. The individual from North Platte was obtained on 14 July 2017 by personnel of the Nebraska Game and Parks Commission. This hispid cotton rat was an adult female carrying two embryos in the right uterine horn and two in the left horn, with each measuring 39 in crown-rump length. This pregnant female weighed 138.6.

Microtus pennsylvanicus pennsylvanicus

Meadow vole

Specimens examined (90).—Dawes County: below dam, Box Butte Reservoir, T29N, R49W, Sec.33, N1/2 [≈11.5 mi E Marsland; 42.9624, -103.5293], 3 (UNSM ZM-23313–15); East Ash Creek, T31N, R50W, Sec.28, W1/2 [≈11 mi S, 3.5 mi E Whitney; 42.6324, -103.2004], 1 (UNSM ZM-24780); Pepper Creek Outdoor Learning Center, T30N, R48W, Sec.28 [≈19.5 mi S, 1.5 mi E Chadron; 42.5456, -102.9600], 33 (UNSM ZM-23282–308, ZM-23310–12, ZM-24782–83); West Ash Creek Campground, T31N, R51W, Sec.25, SE1/4 [≈11 mi S,1 mi E Whitney; 42.6297, -103.2497], 1 (UNSM ZM-24781). Sheridan County: Dyke Ranch, 2.5 mi S Rushville, T31N, R44W, Sec.10, SE1/4 [42.6762, -102.4638], 7 (UNSM ZM-23382–85, ZM-24797–99); Metcalf Wildlife Management Area, 10.5 mi N Hay Springs, specialty area, creek bottom, T33N, R46W, Sec.13, SE1/4 [42.8318, -102.6818], 11 (UNSM ZM-23390–400); Metcalf Wildlife Management Area, 11.5 mi N, 1.0 mi W Hay Springs, old area, canyon bottom, T33N, R46W, Sec.11, SW1/4 [42.8475, -102.7093], 4 (UNSM ZM-23386–89); T25N, R45W, Sec.4, NE corner [≈8 mi N, 1 mi E Antioch; 42.1814, -102.5712], 6 (UNSM ZM-23377–81, ZM-23401). Sioux Co.: 1.5 mi N, 7.75 mi W Crawford, Fort Robinson Wildlife Management Area, 42.7125, -103.5689, 1 (UNSM ZM-17589); 0.75 mi N, 8.0 mi W Crawford, Soldier Creek Wildlife Management Area, 42.7014, -103.5631, 11 (UNSM ZM-17303–04, ZM-17590–95, ZM-17597–99); 0.5 mi N, 7.75 mi W Crawford, Fort Robinson Wildlife Management Area, 42.6856, -103.5689, 1 (UNSM ZM-17596); Faint Ranch, 10 mi N, 5 mi W Harrison, T33N, R57W, Sec.13, SW1/4 [42.8315, -103.9892], 3 (UNSM ZM-23402–04); 5.5 mi N, 1.75 mi W Harrison, Gilbert-Baker Wildlife Management Area, T32N, R56W, Sec.8, NE 1/4 [42.7661, -103.9173], 2 (USNM ZM-17102, ZM-24834); Guadalcanal Prairie, 5.8 mi S, 3.6 mi W Harrison P.O., T30N, R57W, Sec.1, SW1/4, NE1/4 [42.6045, -103.9575], 3 (UNSM ZM-28988–90). Thayer Co.: 2.8 mi N, 0.25 mi E Chester, T1N, R3W, Sec.13, NW1/4, SW1/4 [40.0499, -97.6112], 3 (UNSM ZM-29090, ZM-29095, ZM-29162).

Remarks.—Jones (1964) had but a single record of the meadow vole in the four northwestern-most Nebraska counties—Box Butte, Dawes, Sheridan, and Sioux. Jones (1964) discussed the report by Merritt Cary (1902) of the small population of meadow voles along Monroe Creek north of the Pine Ridge that formed the basis of Swenk's (1908) report of the species in Sioux County. No specimens were deposited in collections from this population, which lies in the watershed of the Cheyenne River. Our records clearly show that the meadow vole is present and even abundant in this part of Nebraska. Only Box Butte County currently lacks records and there is no apparent reason why these voles will not be found there in mesic areas. The specimens from Dawes and Sheridan counties and many from Sioux County were collected by field parties from Chadron State College with specimens now deposited in the UNSM. Unfortunately, accompanying information about capture sites and local ecology is limited. Of interest is that these records come from three river drainage basins—Cheyenne, Niobrara, and White. The three specimens from Guadalcanal Prairie resulting from our 2004 fieldwork were taken south of the Pine Ridge in the watershed of the Niobrara River. Benedict et

al. (2000) presented documentation that the meadow vole in eastern Nebraska had extended its geographic range south of the Platte River drainage documented by Jones (1964) and into northern Kansas (Frey and Moore 1990). The Thayer County specimens added an eighth county where meadow voles have been found to the seven documented by Benedict et al. (2000) along the Kansas-Nebraska boundary.

The three individuals from Guadalcanal Prairie were two adult females and an adult male taken on 1 August 2004. One of the females was pregnant carrying five embryos, with each embryo measuring 18 in crown-rump length, whereas the other female evinced no gross reproductive activity. The male had testes that measured 19 by 12. These individuals weighed, respectively, 67.3, 42.5, and 70.0; they were captured in a wet meadow used for hay production. Vegetation included rushes (*Juncus* sp.), clover (*Trifolium* sp.), cattails (*Typha* sp.), bulrush, (*Scirpus* sp.), Kentucky bluegrass (*Poa pratensis*), and various forbs. The three individuals from Thayer County were two adult males and an adult female trapped on 28 June 2004 from a weedy borrow ditch along Highway 81 dominated by western wheatgrass, smooth brome, yellow sweetclover (*Melilotus officinalis*), plains sunflower (*Helianthus petiolaris*), and a mix of other native forbs and grasses. The testes of the two males measured 15 by 5 and 14 by 8. The female was pregnant with four embryos in the left horn of the uterus and two in the right horn, with the embryos measuring 3 in crown-rump length. These individuals weighed, respectively, 32.0, 45.5, and 22.0.

The former Chadron State College specimens do have some associated data that demonstrate that these are reproducing populations. In material from Sioux County a male from Gilbert-Baker WMA had testes measuring 13 by 10 and weighed 48.6 on 14 June 1988. From Faint Ranch two females reveal no gross reproductive activity on 16 June and 10 August 1989 and weighed, respectively 30.6 and 64.5, whereas a male from here had testes measuring 11 by 7.5 and weighed 31.6 on 19 June 1989. A male and female vole from Soldier Creek WMA taken on 15 June 1988 weighed 81 and 52; the female was not pregnant and the male's testes measured 17 by 10.

In the large sample from Dawes County taken at the Pepper Creek site, three females were carrying embryos as follows: 3 embryos, crown-rump length, 13, taken 7 March 1979 (weight: 48); 3 embryos, 13 crown-rump length, 25 April 1984 (35.3); 2 embryos, 27 crown-rump length taken 30 June 1979 (45). Fifteen other females taken in June 1979 were recorded as revealing no gross reproductive activity. Seven adult females weighed an average of 35.5 (29–43). Ten adult males taken at Pepper Creek in June 1979 had testes that averaged 14.9 (13–18) by 8.0 (6–10) and they weighed on average 46.9 (36–68). The male taken at East Ash Creek on 15 August 1994 weighed 46.6 and had testes measuring 17 by 9.

In the Chadron material from Sheridan County, a female from north of Antioch carried 5 embryos on 29 May 1974 (42), whereas two females taken at Dyche Ranch on 14 and 19 July 1989 evinced no gross reproductive activity (46 and 44). Six adult males from Sheridan County had the following testes measurements: north of Antioch—29 May 1974, 15 by 10 (61); Dyche Ranch—17 July 1989, 12 by 8 (39.1); Metcalf WMA—17–19 August 1993, 16 by 9.5 (41), 16 by 8.5 (47.5), 16 by 9.5 (60), 15.5 by 8.5 (46.5).

We follow Jones (1964) and Benedict et al. (2000) in assigning our specimens to the nominate subspecies. The source areas for populations in northwestern Nebraska would be from the east along the Niobrara River in Cherry County or from the south in Scotts Bluff County along the North Platte River. Voles from both of these areas were assigned by Jones (1964) to *M. p. pennsylvanicus*. The most interesting specimens are those from northwestern Sioux County, north of the Pine Ridge and in the Cheyenne River Basin. Jones (1964) speculated that this population could possibly be related to *M. p. insperatus*, which occurs to the north in the Black Hills of South Dakota and on northward to Montana. Although we have 5 specimens from this area (Faint Ranch, 10 mi N, 5 mi W Harrison and 5.5 mi N, 1.75 mi W Harrison, Gilbert-Baker Wildlife Management Area), the exact relationship of this population of meadow voles remains open until a larger sample is available for study, but we now know that there are extant populations of the meadow vole in this part of Nebraska.

We are aware of potential taxonomic changes based on genetic data that indicate that *Microtus pennsylvanicus* may be composed of as many as three distinct species (Jackson and Cook 2020). We are not prepared at this point to make these major taxonomic changes without more additional studies.

Microtus pinetorum nemoralis

Woodland vole

Specimens examined (8).—Nemaha Co.: bluffs W of Missouri River, 0.6 mi S Brownville, 40.3885, -95.6564, 2 (UNSM ZM-28907–08). Richardson Co.: Indian Cave State Park, 40.2504, -95.5377, 1 (UNSM ZM-29351); Indian Cave State Park, T3N, R16E, Sec.1, SE1/4 [40.2514, -95.5644], 1 (UNSM ZM-26100); Indian Cave State Park, T3N, R17E, Sec.7, NE1/4 [40.2438, -95.5460], 1 (UNSM ZM-28170); 1.5 mi N, 2.75 mi E Barada, Indian Cave State Park, T3N, R17E, Sec.8 [40.2406, -95.5262], 1 (UNSM ZM-28252); Rulo Bluffs Preserve, 2.2 mi S, 4.4 mi E Rulo P.O., 40.0222, -95.3502, 1 (UNSM ZM-28896). Sarpy Co.:

in Bellevue, Fontenelle Forest Nature Center, 41.1792, -95.9079, 1 (UNSM ZM-16929).

Remarks.—We report eight new specimens of the woodland vole, which is considered critically imperiled in Nebraska by the Natural Heritage Program. Nebraska populations occur along the western margin of the geographic range of the species, with specimen records known from only five counties—Gage, Nemaha, Richardson, Sarpy, and Washington (Jones 1964; Benedict et al. 2000). There is also an old literature record without voucher specimens in Otoe County cited by Jones (1964:234). The northernmost specimen is one from Neale Woods Nature Center in southern Washington County (Benedict et al. 2000) and the next specimen to the south is known from Fontenelle Forest Nature Center in Sarpy County (Benedict et al. 2000). Here we add a new specimen from Fontenelle Forest found dead along a forest trail in June 1984. Saunders (1985) reported observations of several woodland voles in Fontenelle Forest during the late 1970s and the early 1980s indicating a thriving population in the area. The only specimens previously known from Nemaha County are six individuals from London (probably London precinct) housed in the National Museum of Natural History. These voles were collected by G. A. Coleman 21–22 March and 21 April 1893. The specimens from Richardson County were taken in 1957 and 1958 (Jones 1964). Our specimens document that healthy, reproducing populations of woodland voles still occur in Nemaha (specimens from 2004) and Richardson (specimens from 1988, 1998, 2001, 2004, 2007) counties.

An adult male taken 3 October 1998 in Indian Cave State Park had testes that measured 8 by 5 and had a weight 25.7. Four of our female woodland voles were reproductively active. The two females from Nemaha County were taken on 28 June 2004, with one carrying three embryos (1 in left uterine horn, 2 in the right) measuring 27 in crown-rump length and the other was lactating, presenting two placental scars. A female from Indian Cave State Park was carrying two embryos (1 in each uterine horn), measuring 21 in crown-rump length when taken on 8 September 2007. The female from near Rulo was lactating when trapped on 22 June 2004. Weights of these females in the order presented above were 49.3, 36.8, 31.6, and 38.0. The lactating female from 22 June 2004 was captured by hand during the day in a deep ravine vegetated with mature forest including sycamore, American basswood, hophornbeam, chinquapin oak, ash, American elm, and pawpaw. The two voles caught on 28 June 2004 were caught in logged woods dominated by shagbark hickory (*Carya ovata*), juniper, American elm, and black walnut; one from near a ridge top and the other from a forest edge at the bottom of a hill. Notes accompanying the specimen from northeast of Barada indicate that it was captured "Six ft. high in crotch of small linden tree." This trap had previously captured an individual of *Blarina hylophaga*.

Vulpes fulva regalis

North American red fox

Specimens examined (2).—Kimball Co.: Highway 30, ≈4 mi E Wyoming State Line [41.1986, -103.9782], 1 (UNSM ZM-28820); 0.1 mi N, 3.5 mi W Kimball P.O., T15N, R56W, Sec.27, SE1/4 [41.2372, -103.7245], 1 (UNSM ZM-28821).

Remarks.—The red fox occurs across the U.S. except the deserts of the southwest and driest parts of the plains. They occupy many habitats including forest edges, riparian sites, and areas altered by human activity (Jones et al. 1983). Jones (1964) showed this species occupying most of Nebraska except many western counties with records in the Panhandle only along the North Platte River. These same records are repeated in Hall (1981). Jones et al. (1983) showed this fox inhabiting the entire state but did not map records to support this hypothesis. On 14 and 17 July 2004, we salvaged road-killed red foxes in Kimball County at two locations. All that could be preserved of these animals were partial skins. The surrounding habitat was a mix of short-grass prairie, agricultural fields, and open cottonwood forests. In a report on the occurrence of *Echinococcus multilocularis* infecting wild predators, Storandt et al. (2002) documented the occurrence of this parasite in red fox occurring in Box Butte and Scotts Bluff counties in the Panhandle as well as one red fox from Morrill County that was negative for the parasite. Jones (1964) had records from Morrill and Scotts Bluff counties, but the red fox was not previously reported from Box Butte County. These two new county records support the assertions of Jones et al. (1983) that red fox occurs in all of the Panhandle of Nebraska with the possible exception of three northwestern-most counties—Dawes, Sheridan, and Sioux—where there are no records in the literature.

Several recent genetic studies have presented a much clearer picture of the history and relationships of populations of red fox in the central plain states. Statham et al. (2012) studying mtDNA concluded that in the central U.S. red foxes are a native stock but appear to have a complex history of migratory populations. Statham et al. (2014), examining mtDNA of red fox samples throughout its distribution in North America, Eurasia, and Africa, concluded that Eurasian-African populations are distinct at the species level from North American populations. This is an arrangement that was in common use until the late 1950s when Churcher (1959) presented

evidence that these two populations were a single species under the name *Vulpes vulpes* (an arrangement first proposed by Rausch 1953). One can see the transition in nomenclature in the editions of the *Mammals of North America* where the name *V. fulva* was used in 1959 (Hall and Kelson 1959) and *V. vulpes* was used in 1981 (Hall 1981). Statham et al. (2014) recommend returning to using the name *V. fulva* for North American populations and restricting *V. vulpes* for Eurasian and African populations. Data from Y-chromosome markers also appear to support recognition of two species of red fox (Rando et al. 2017). We believe these new genetic data are strong enough to revert to the use of *Vulpes fulva* for the North American red fox.

Spilogale putorius interrupta

Eastern spotted skunk

Specimens examined (3).—Boyd Co.: 0.75 mi E Spencer, on Highway 12 [42.8612, -98.6829], 1 (USNM ZM-30976). Brown Co.: Long Pine [42.5367, -99.7030], 1 (UNSM ZM-30975). Cherry Co.: Valentine National Wildlife Refuge, on Hwy 83, 42.4563, -100.5446, 1 (UNSM ZM-31047).

Additional record.—Dawes Co.: on Hwy 20 west of Chadron airport [≈4.5 mi W Chadron; 42.8224, -103.1050]. (Nebraska Natural Heritage Database, Nebraska Natural Heritage Program, Nebraska Game and Parks Commission, Lincoln, NE; Source Feature ID 26477).

Remarks.—We report three specimens of the eastern spotted skunk obtained in 2013 and 2017 in northern Nebraska. This species is worthy of continued monitoring in Nebraska because it has undergone a major decline in population throughout its geographic range since the 1940s (Landholt and Genoways 2000, Gompper and Hackett 2005). Because of general concerns about the species, its status has been elevated to vulnerable by the International Union for Conservation of Nature (Gompper and Jachowski 2016). The causes of this decline in abundance are not well understood but the increased use of pesticides in agriculture following World War II has been suggested as has changing land use during this period (Choate et al. 1974, Landholt and Genoways 2000, Gompper 2017). This species deserves more study and protection in Nebraska, as has occurred in South Dakota (Fino et al. 2019).

Our specimens include an adult male from Boyd County obtained on 5 May 2013, an adult female from Brown County obtained in 2013 (no specific date available), and an adult female recovered on 20 February 2017 from Cherry County. All individuals were salvaged from road-kills by personnel of the Nebraska Game and Parks Commission. The male had testes that measured 25 by 14. No reproductive data were available for the female from Brown County and the female from Cherry County was judged to be not pregnant. The male weighed 668.5 and the first female weighed 500 and the other 605. These three locations are in general association with the Niobrara River and its tributaries. The situation in which the spotted skunk from the Valentine National Wildlife Refuge was obtained was detailed by Pesek (2017). In addition to specimens listed above, a road-killed individual was documented by Nebraska Game and Parks personnel from west of the Chadron airport, Dawes County, on 15 April 2009. This site is just north of the Pine Ridge and near the White River.

In a recent ecological study of *Spilogale* conducted in south-central Wyoming, Boulerice and Zinke (2017) found that, contrary to earlier studies, vegetative cover was of little importance to habitat use by spotted skunks. Instead, they found a strong relationship between the amount of rocky outcrops in the surrounding area and the presence of spotted skunks. Examining these Nebraska records in view of this study, spotted skunks being found along the Niobrara River and Pine Ridge should have been expected. Some of the land along the Niobrara River is in Federal and State control, but much of it is in private ownership, which is devoted primarily to ranching. In many places rugged cliffs line the river as it cuts through steep Oligocene and Miocene rock formations, which are covered in pine and eastern deciduous forest. The Pine Ridge of northwestern Nebraska is an escarpment between the Niobrara and White rivers. The escarpment has been eroded to form a region of forested buttes, ridges, and canyons. The dominant tree in the Pine Ridge is the ponderosa pine (*Pinus ponderosa*), with cottonwoods in moist canyon bottoms. If this habitat profile for eastern spotted skunks in Nebraska is accurate, other areas of the state where the species may be expected would be along buttes and valleys of the Wildcat Hills south of the North Platte River and the areas of rocky bluffs along the Missouri River.

Several lines of evidence demonstrate that spotted skunks in eastern and western North America are distinct species, with Nebraska skunks being part of the eastern population to which the name *S. putorius* applies (Mead 1968, Hsu and Mead 1969, Dragoo et al. 1993). Our specimen from Cherry County was included in the study by Shaffer et al. (2018) of genetic variation in this species. Shaffer et al. (2018) recognized three subspecies in eastern spotted skunk, with the specimen from Nebraska grouping with populations on the Northern Great Plains from Iowa, Kansas, and South Dakota. The scientific name *S. p. interrupta* was applied to these spotted skunk populations.

Puma concolor cougar

Mountain lion

Specimens examined (4).—Dakota Co.: South Sioux City [42.4698, -96.4140], 1 (UNSM ZM-29063). Sarpy Co.: on I-80, near Gretna [41.0949, -96.2532], 1 (UNSM ZM-28815). Scotts Bluff Co.: Scottsbluff [41.8676, -103.6642], 1 (UNSM ZM-29029); *in* Scottsbluff, 2901 Park Lane, 41.8768, -103.6550, 1 (UNSM ZM-30745).

Remarks.—The first documented modern appearance of the mountain lion in Nebraska was in 1991 when one was shot near Fort Robinson State Park in Sioux County (Genoways and Freeman 1996). Subsequent sightings have been made statewide (LaRue et al. 2012, LaRue and Nielsen 2016, Wilson 2016) as the excellent website maintained by the Nebraska Game and Parks Commission documents (<https://maps.outdoornebraska.gov/puma/>). There is a reproducing population in the Pine Ridge area of northwestern Nebraska as documented by Wilson et al. (2010), where intermittent hunting seasons have been allowed (LaRue and Nielsen 2016). There are also concentrations of sightings along the Niobrara River in northern Nebraska and along the North Platte River and Wildcat Hills in the extreme western part of the central Panhandle. We endeavor to document with museum-based records the expansion of mountain lions throughout the state from the reproducing population in the Pine Ridge. Following the initial specimen from Sioux County, Benedict et al. (2000) added specimens from Box Butte and Scotts Bluff counties, as well as an additional record from Sioux County. Hoffman and Genoways (2005) added the first record outside of the Panhandle, with a specimen from Howard County in central Nebraska. Wilson et al. (2010) added a specimen record from Dawes County, which was the third county with a record in the Pine Ridge area.

Here we have documented records from two additional counties, including Dakota County in extreme northeastern Nebraska and Sarpy County on the eastern boundary of the state, as well as two more specimens from Scotts Bluff County along the North Platte River. This brings the number of counties to eight for which we now have museum records of the mountain lion in Nebraska. The individual from South Sioux City is represented by an unsexed postcranial skeleton taken by Nebraska Game and Parks personnel on 23 November 2004. The immature male from near Gretna weighed ≈52 kg and was killed by a collision with an automobile on Interstate 80 on 6 November 2005. The hide of this animal was made into a taxidermy mount currently on display in Morrill Hall on the UNL campus. The two specimens from Scottsbluff were a male and female taken, respectively, on 2 October 2006 and 25 January 2009. The female weighted ≈37 kg, but no other data were recorded.

There is evidence that the initial Pine Ridge population emigrated from the Black Hills of South Dakota (Jenks 2018). While no published genetic studies include Nebraska mountain lion specimens, genetic and isotopic studies suggest that Nebraska populations may have connections to eastern Wyoming and North Dakota populations as well (Henaux et al. 2011, Juarez et al. 2016, LaRue et al. 2019). Riparian areas may be important habitat and movement corridors for mountain lions into and across Nebraska (Henaux et al. 2011, LaRue and Nielsen 2011). Given the present levels of sightings in the state, estimates of abundance, occupancy, demonstrated vagility of this species, suitable habitat available, and population growth modeling (LaRue and Nielsen 2016), it is our speculation that breeding populations in the state now extend beyond the Pine Ridge area. The demography, genetics, and morphology of this expanding population should be carefully monitored and targeted for more rigorous scientific study so that the status of mountain lions in Nebraska is clearly understood. Any lions collected by Game and Park staff should be sampled for DNA and material deposited in the UNSM to be accessible to the broader scientific community.

Cervus canadensis nelsoni

American elk or wapiti

Sight records.—Garfield Co.: no specific locality (Ducey 2018). Lancaster Co.: Lincoln [40.7538, -96.6896] (Pluhacek 2011).

Remarks.—Jones (1964) believed that the American elk had been extirpated from Nebraska in the early 1880s, but he described a report from the Nebraska Game and Parks Commission that a bull elk had been seen in the area of Berea, Box Butte County, in 1958. This was the beginning of the reintroduction of a wild elk herd in Nebraska, which initially originated from Rocky Mountain elk transplanted from Yellowstone National Park to the Rawhide Buttes near Lusk, Wyoming (Hygnstrom et al. 2005, Fricke et al. 2008). This reintroduced herd expanded into the Pine Ridge area of Nebraska becoming established in the Bordeaux Creek drainage near Chadron. By 1985 there were ≈75 elk in the herd and landowner complaints had reached a point that hunting seasons were held in 1986 and 1987. By 1997, there was ≈150 elk and permanent hunting seasons were instituted in 1995. The Game and Parks Commission had established seven Elk Management Units (EMU) in the western half of Nebraska by 2008, which are still in use today (Gruntorad and Chizinski 2020). Our two sight records are of individuals that have been observed to the east of the EMU in the last 10 years, indicating this highly mobile species is still in the

process of re-establishing populations statewide as they were in pre-settlement times.

The sighting from Garfield County was of two bulls that interlocked their antlers and eventually drowned in a ranch pond. Each animal was estimated to weigh ≈360 kg (=800 lb). Local residents reported that elk were uncommon in the area (Ducey 2018). The elk from Lincoln was a "full-grown bull elk" that was observed in the Knolls Country Club area in the western part of the city. It was also estimated to weigh at least 360 kg. The animal was sacrificed by the Lincoln Police because it had a broken leg. The Lincoln Police reported that several other elk were seen in the previous two weeks west of Lincoln, but none entered the city (Pluhacek 2011).

This species has been known over the last 50 years by the scientific name *Cervus elaphus* (McCullough 1969, Hall 1981). However, recent work by Polziehn and Strobeck (2002) and Ludt et al. (2004) provide evidence that we should revert to the earlier name *C. canadensis* for this species. Their genetic studies showed that the red deer of Europe (*C. elaphus*) is a species distinct from the elk of Asia and North America to which the name C. *canadensis* should be applied. Jones (1964) assigned the original population of American elk in Nebraska to the subspecies *C. c. canadensis*, but we have assigned the re-established population to the Rocky Mountain subspecies *C. c. nelsoni* because at least the core of Nebraska's population was derived from Yellowstone National Park.

Discussion

Knowledge of distributions and status of mammals in any state naturally accrues over time. Nebraska is fortunate because it has over a century of data tracking the distribution and status of mammals in the state. Although there have been notable efforts in the past to delineate the occurrence of species across Nebraska's 93 counties (Cary [1905], Swenk 1908, Jones 1964), the evaluation of new specimen records and the updating of species distributions approximately every 3 to 5 years provides indispensable information for researchers and state officials. As discussed in this paper, numerous studies have occurred of individual species or groups of mammals, such as bats, since 2000, but general survey work aimed at monitoring the health and status of mammalian populations should remain an active part of the state's management plan. Our brief summer survey discovered a species new to the mammalian fauna of the state, *Sorex nanus*, and new county records for 18 species, as well as adding to our knowledge of the natural history of these species in the state. "An increased awareness of the importance of biodiversity and natural history information has increased the significance of specimen data and its use in understanding and predicting natural and anthropogenic impacts on the environment, including climate change" (Braun et al. 2020). We agree and assert that more regular and systematic natural history surveys of biodiversity in Nebraska backed by voucher specimens and peer-reviewed publications are necessary, as exemplified by our documentation of a species formally undocumented in the state, though likely historically present.

All indications are that climate change will impact mammal distributions significantly over the coming decades (Schloss et al. 2012). Ceballos et al. (2017) found that of 177 species of mammals studied, all had lost 30% or more of their geographic ranges and that more than 40% had severe population declines. In Nebraska, we know that mammals are shifting their geographic ranges (Benedict et al. 2000), with some attempting to extend populations into the state such as *Dasypus novemcinctus* (Freeman and Genoways 1998), *Tadarida brasiliensis* (Genoways et al. 2000), and *Alces alces* (Hoffman et al. 2006), whereas others such as *Nycticeius humeralis*, *Perimyotis subflavus*, and *Sigmodon hispidus* have expanded their geographic ranges within the state. It is more difficult to document population declines and loss of geographic range because it involves demonstrating a negative. We know some mammals that occurred in Nebraska became extinct or were extirpated following European settlement. Some of these extirpated species (for example, *Puma concolor* and *Cervus canadensis*) are now reclaiming portions of their geographic ranges, but still occupy less area today than when the state was originally settled (Hoffman and Genoways 2005). Some species (*Mephitis mephitis*, *Mustela frenata*, and *Spilogale putorius)* have suffered population declines since the 1940s and may have lost geographic range as well (Landholt and Genoways 2000). One of the better-documented ongoing geographic range contractions is affecting the white-tailed jackrabbit (*Lepus townsendii*), a native species in Nebraska, which is predicted to be lost from the state's fauna (Brown et al. 2020).

The Nebraska Natural Heritage Program (NENHP) maintains a list of at-risk species in the state (see Appendix 1). There is a complex system of ratings to identify Tier 1 species ("that are globally most at-risk of extinction and which occur in Nebraska") and Tier 2 species ("that are not at-risk from a global or national perspective but are rare or imperiled within Nebraska;" NENHP 2019:31). There are 39 species on the list of mammals, but six of these species are extirpated and two others (*Lontra canadensis* and *Ovis canadensis*) have been extirpated and replaced with non-native populations. There are 14 species listed as Tier 1 and 15 as Tier 2, with two species listed but unclassified (*Dasypus novemcinctus* and *Urocitellus elegans*;

NENHP 2019:1–2). The extant species on the lists of Tier 1 and 2 are tracked, but it is not clear what this exactly entails. Certainly, our survey of mammals was part of this tracking effort, but it is unclear how regularly these surveys are being conducted. Given the rapid changes that have already been documented in Nebraska and those that are anticipated with continuing climate change and shifts in land use, information on current distribution patterns and ecology of these species will remain critical to making informed decisions about conservation measures and management strategies for mammalian species in Nebraska. We urge the Nebraska Game and Parks Commission to conduct surveys on a nearly continuous basis for those species listed as Tier 1 and 2. Whenever possible, voucher specimens should be preserved in accredited natural history collections with accompanying ecological and environmental information. It will be critical that these lists be reviewed and updated on a 3 to 5 year basis as shifting and contracting geographic distributions of species will be occurring with increasing speed. It also is critical that research be focused on several species of special concern, including *Lepus townsendii*, *Sciurus carolinensis*, *Neotoma cinerea*, *Spilogale putorius*, *Mephitis mephitis*, *Mustela frenata*, and *Vulpes velox*.

Finally, so much information has accumulated on mammals in Nebraska since Jones (1964), it is clear that a new summative publication is a high priority need. In this paper, we have tried, at least in part, to document the explosion of literature in the last 20 years.

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Appendix 1.—Status of Nebraska mammals from "Natural Communities and Rare, Declining, and Extirpated Species of Nebraska" from the Nebraska Natural Heritage Program, Nebraska Game and Parks Commission (version 12 March 2020). Species include those listed by the Natural Heritage Program and assessed in our current study, which are marked with an asterisk (*). An additional ten mammals not on the Nebraska Natural Heritage Program list, but reported in this study are indicated by a dagger (†). "Nebraska status" is as determined by the Natural Heritage Program. Comments are our assessments based on ongoing studies of Nebraska mammals. Species are listed in an alphabetical sequence under each mammalian Order for the ease of use. Taxonomic and common names have been updated based on information outlined in this paper.

Order and species name	Common name	Nebraska status	Comments
Order Eulipotyphla (shrews)			
Sorex merriami	Merriam's shrew	Critically imperiled	Marginal distribution; known from Dawes, Sheridan, and Sioux counties; status poorly understood
* *Sorex nanus*	Dwarf shrew	Critically imperiled	Marginal distribution; one specimen from extreme northwestern Nebraska; status poorly understood
Order Cingulata (armadillos and relatives)			
* *Dasypus novemcinctus*	Nine-banded armadillo	Not Applicable	Pioneering individuals entering state from Kansas; no breeding population known
Order Chiroptera (bats)			
* *Aeorestes cinereus*	North American hoary bat	Vulnerable	Migratory species that breeds statewide; may be declining; threat from wind farms
Corynorhinus townsendii	Townsend's big-eared bat	Critically imperiled	Known from a single individual from Sheridan County; population present in Black Hills
† *Eptesicus fuscus*	Big brown bat	Not evaluated	Now known statewide
* *Lasionycteris noctivagans*	Silver-haired bat	Vulnerable	Migratory species with local breeding populations; may be declining; threat from wind farms
* *Lasiurus borealis*	Eastern red bat	Vulnerable	Migratory species that breeds statewide; some may overwinter; population may be declining; threat from wind farms
* *Myotis lucifugus*	Little brown bat	Vulnerable/Imperiled	*M. l. carissima* (vulnerable), *M. l. lucifugus* (imperiled); threat from habitat loss, wind farms, and white-nose syndrome
* *Myotis septentrionalis*	Northern long-eared myotis	Critically imperiled	Federally threatened species; threat from white-nose syndrome and wind farms
Myotis thysanodes pahasapensis	Fringed myotis	Critically imperiled	Small population confined to pine forests in extreme western Nebraska; at eastern edge of geographic range
Myotis volans	Long-legged myotis	Critically imperiled	Small population confined to pine forests in extreme western Nebraska; at eastern edge of geographic range
† *Nycticeius humeralis*	Evening bat	Not evaluated	Population expanding geographic range in Nebraska; migratory species; threat from wind farms
* *Perimyotis subflavus*	Tricolored bat	Vulnerable	Geographic range may be expanding; threat from white-nose syndrome

Order and species name	Common name	Nebraska status	Comments
Order Carnivora (dogs, cats, and relatives)			
Canis lupus	Gray wolf	Extirpated	Original population *C. l. nubilus* possibly extinct; one individual recently taken in Greeley County genetically linked to Great Lakes populations (*C. l. lycaon*)
∗ *Puma concolor*	Mountain lion	Critically imperiled	Original population extirpated; reinvaded state from Wyoming and South Dakota beginning in 1990s; expected statewide
Gulo gulo	Wolverine	Extirpated	Only three historical records
Lontra canadensis	River otter	Apparently secure	Original population *L. c. lataxina* extirpated; non-native animals re-introduced from populations across North America
Mustela frenata	Long-tailed weasel	Imperiled	Populations have declined since1940s; threats from habitat loss and use of pesticides and herbicides
Mustela nigripes	Black-footed ferret	Extirpated	Federally endangered; extirpated in Nebraska; exists elsewhere as re-introduced and protected populations
∗ *Spilogale putorius*	Eastern spotted skunk	Critically imperiled	Populations have declined since1940s; threats from habitat loss and use of pesticides and herbicides
Ursus americanus	Black bear	Extirpated	Wandering individual in western Nebraska in recent years likely from Wyoming; populations building in Iowa and Missouri
Ursus arctos horribilis	Grizzly bear	Extirpated	Only historical records
† *Vulpes fulva*	North American red fox	Not evaluated	Populations increasing; now probably statewide
Vulpes velox	Swift fox	Imperiled	Range contraction from nearly statewide to west quarter of state; threats from habitat loss and predator control programs
Order Artiodactyla (even-toed ungulates)			
Bison bison	Bison	Extirpated	Present in Nebraska as confined herds; extinct in the wild
† *Cervus canadensis nelsoni*	American elk or wapiti	Not evaluated	Original population *C. c. canadensis* extirpated; re-entering the state from a population from Yellowstone National Park re-introduced in the Rawhide Buttes, Wyoming; several established populations in state
Ovis canadensis canadensis	Mountain sheep	Imperiled	Original subspecies *O. c. audubonii* is extinct; re-introduced from Rocky Mountain populations
Order Lagomorpha (rabbits)			
Lepus townsendii	White-tailed jackrabbit	Vulnerable	Population declining and geographic range contracting northward; Brown et al. (2020) believed this species will be extirpated from Nebraska in the near future; in need of immediate study

Order and species name	Common name	Nebraska status	Comments
Order Rodentia (rats and mice)			
Cynomys ludovicianus	Black-tailed prairie dog	Vulnerable	Greatly reduced populations and geographic range; may occupy only 2% of original geographic range
Glaucomys volans	Southern flying squirrel	Critically imperiled	Marginal distribution; along western edge of geographic range of species; confined to the Missouri River lowlands south of Omaha
† *Microtus pennsylvanicus*	Meadow vole	Not evaluated	Now known statewide; relationship of population north of Pine Ridge in need of study
* *Microtus pinetorum*	Woodland vole	Critically imperiled	Marginal distribution; along western edge of geographic range of species; known only from Gage, Nemaha, Richardson, Sarpy, and Washington counties
Neotoma cinerea	Bushy-tailed woodrat	Vulnerable	Marginal distribution; found only in western Panhandle
† *Neotoma floridana attwateri*	Attwater's eastern woodrat	Not evaluated	Population confined to southeastern part of state in Gage, Jefferson, and Pawnee counties; documented presence in this region over last 25 years
Neotoma floridana baileyi	Bailey's eastern woodrat	Apparently secure	Isolated population occurring along central Niobrara River
† *Onychomys leucogaster arcticeps*	Northern grasshopper mouse	Not evaluated	Now known to occur throughout eastern third of Nebraska
* *Perognathus fasciatus*	Olive-backed pocket mouse	Critically imperiled	Declining population in western Nebraska
† *Perognathus flavescens flavescens*	Plains pocket mouse	Not evaluated	Now documented from Sioux County; also found on sandy soils in western Nebraska
* *Perognathus flavescens perniger*	Plains pocket mouse	Unranked	Persistent populations in suitable habitats (friable soils with moderate to sparse vegetation) of northeastern and east-central Nebraska (Geluso and Wright 2013)
Perognathus flavus	Silky pocket mouse	Critical imperiled	Extremely rare in western half of the state
Sciurus carolinensis	Eastern gray squirrel	Vulnerable	Marginal distribution; along western edge of geographic range of species; known only along the Missouri River Valley from Washington County southward
† *Sciurus niger*	Eastern fox squirrel	Not evaluated	Expanding westward across state; now known from the southwestern Panhandle; may be statewide
† *Sigmodon hispidus*	Hispid cotton rat	Not evaluated	Invading state from Kansas; geographic range expanding northward and westward
Tamias minimus	Least chipmunk	Critically imperiled	Occurs only on slopes and canyons of the Pine Ridge in northwestern Nebraska; rare

Order and species name	Common name	Nebraska status	Comments
* *Tamias striatus*	Eastern chipmunk	Critically imperiled	Marginal distribution; along western edge of geographic range of species; known only along Missouri River Valley from Douglas County southward and along lower Platte River Valley to Nickerson, Dodge County; may now be confined to Nemaha and Richardson counties
* *Thomomys talpoides cheyennensis*	Cheyenne northern pocket gopher	Imperiled/Vulnerable	Limited geographic range in southwestern Panhandle; threat from rodent control programs
* *Thomomys talpoides pierreicolus*	Pierre northern pocket gopher	Imperiled/Vulnerable	Limited geographic range in northwestern Panhandle; threat from rodent control programs
Urocitellus elegans	Wyoming ground squirrel	Extirpated	Known only from single individuals from Kimball and Morrill counties